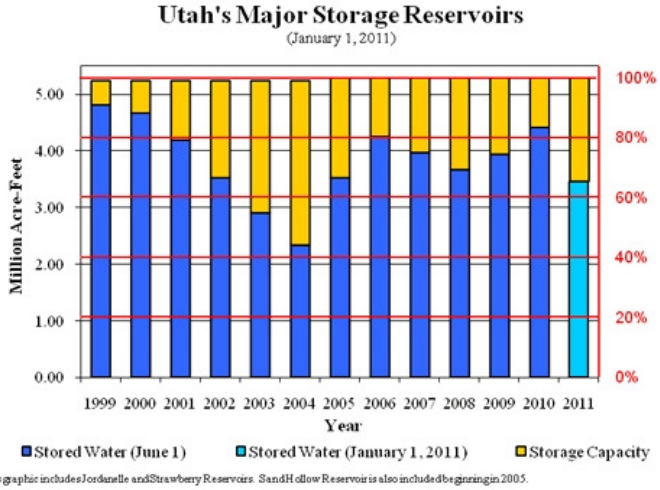
Drought

Profiling Hazard Event

Requirement §201.4(c)(2)(i): [The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate … .

Drought is a normal recurrent feature of climate, although many, in Utah, erroneously consider it a rare and random event. It occurs in virtually all-climatic zones, while its characteristics vary significantly from one region to another. Droughts, simple put, are cumulative hazards, which result from long periods of below normal precipitation. Drought is a temporary aberration and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Most experts believed the State's last drought ended in 2005. Water reservoirs storage has averaged 80% since 2005.

Utah is the second driest state in the nation. Despite experiencing significantly less precipitation than the rest of the United States, Utah has one of the highest water usage rates in the nation. According to the Utah State University Center for Water Efficient Landscaping, Utahans consume 269 gallons of water per capital per day, which is significantly more than the national average of 179 gallons per capita per day.



Droughts can potentially create water shortages throughout the state, causing strains on water availability to homes, businesses, and farms. According to the Glossary of Meteorology (1959), drought is defined as a period of abnormally dry weather sufficiently prolonged enough for the lack of water to cause serious hydrologic imbalance in the affected area. The severity of the drought and its impacts on an area depend on the degree of moisture deficiency, the duration, and geographical extent of the region affected. The National Weather Service (2007) indicates that drought can be defined in four different ways:

1. Meteorological: a measure of departure of precipitation from normal. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.

2. Agricultural: refers to a situation where the amount of moisture in the soil no longer meets the needs of particular crop.

3. Hydrological: occurs when surface and subsurface water supplies are below normal.

4. Socioeconomic: refers to the situation that occurs when physical water shortages begin to affect people.

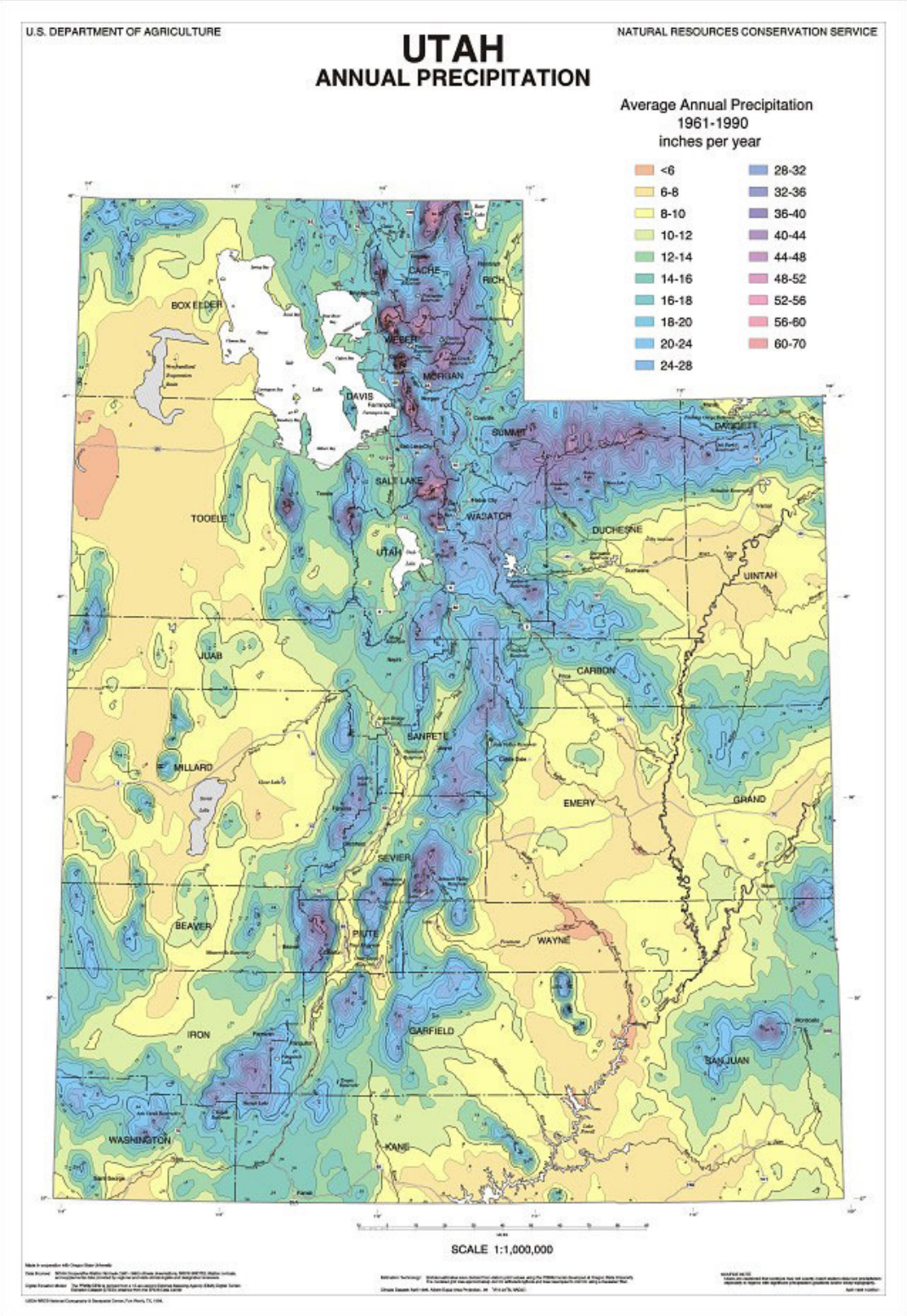


Figure I-6

Impacts of Drought

Economic

- Unemployment from drought related declines in production
- Decreased land prices
- Loss to industries directly dependent on agricultural production (machinery and fertilizer manufactures, food processors, dairies, etc)
- Strain on financial institutions (foreclosures, more credit risk, capitol shortfalls)
- Revenue losses to federal, state, and local governments from reduced tax base
- Reduction of economic development
- Rural population loss and relocation to larger cities
- Loss to recreation and tourism industry
- Energy related effects
- Water suppliers revenue shortfalls
- Higher cost of water transport
- Decline in food production causes increase in food prices and increase in importation of food

Social

- Mental and physical stress
- Health related low flow problems including cross-connection contamination diminished sewage flows, increased pollutant concentrations, and reduced fire-fighting capabilities
- Loss of human life
- Public safety concerns caused by increased threat of forest and range fires
- Increases in conflicts of water users
- Changes lifestyles of those living in rural areas
- Reduction of modification of recreation activities
- Public dissatisfaction with government drought response plan

Environmental

- Damage to animal species
- Reduction and degradation of fish and wildlife habitat
- Increased contact of wild animals with agricultural producers
- Loss of biodiversity
- Lower water levels in reservoirs and lakes
- Reduced stream flow
- Loss of wetlands
- Increased ground water depletion, land subsidence, reduced recharge
- Increased number and severity of wild fires
- More dust and pollutants in the air
- Visual and landscape qualities diminished

Droughts typically affect Utah in two ways 1) results from water shortages within reservoirs affecting irrigation and eventually culinary water supplies, if the drought lasts more than two years. 2) Soil moisture drought, where dry farmers lose their crops. Public safety threats do no

usually become visible in communities until the third year of drought, when culinary water supplies are low.

Historical Droughts

Droughts are not uncommon occurrences in Utah. As of 2005, Utah is no longer in a drought cycle according to the Utah Center for Climate and Weather (UCCW). Previous years of drought occurred during the water-years of 1998-1999 through 2003-2004. The UCCW notes that Utah has experienced 10 droughts in the past 205 years with the longest drought lasting 14 years between 1870 and 1883.

The Utah Division of Water Resources annotates in their 2007 state-wide drought report that analysis of PDSI (Palmer Drought Severity Index) data collected in the state's seven climate divisions show six significant droughts occurring from 1898-1905, 1928-1936, 1946-1964, 1976-1979, 1987-1992, and 1999-2004. The figure below illustrates the seven Utah Climate Divisions. These climate divisions are areas within the state that are experience similar climatic regimes.

The State or Utah uses the Palmer Drought Severity Index referred to as the (PDSI) to quantify the existence of a drought. Using the PDSI, drought is expressed as a negative number. Much of the basis, used by the State, to determine drought years, or drought periods, comes from the PDSI. In addition, the State Climatologist, the National Geophysical Data Center of NOAA, and the National Drought Mitigation Center use the PDSI. Further information on the Palmer Drought Severity Index can be found in Appendix F.

For the most part droughts no longer affect the availability of drinking water, thus no longer place people's lives at risk, the same cannot be said for a person's livelihood. Numerous water projects throughout the state have placed enough water in storage to insure the supply of drinking water. Yet, prolonged droughts still have a significant effect on agricultural and agribusinesses, within the state dependent on irrigation water.

Droughts have significant impact on the natural world. Species over time adapt to the natural world in which they live, becoming depended on constant factors, one of those being a certain amount of water. The flora and fauna of a given area have an ability to adjust to a certain amount of environmental change but as drought conditions persist mortality rates across the ecosystem begin to rise. Prolonged droughts place a tremendous burden on wildlife habitat, causing mortality in plant species and heightening the risk of wildfire, as habitat is lost or changed, those animals depended on it, are also lost or must relocate.

According to Utah's annual PDSI averages, Utah has experienced as many as 60 years of drought out of the past 100 years, and several of these have been multi-year droughts. A more detailed look at Utah's drought is available in each of Utah's seven multi-jurisdictional Pre-Disaster Mitigation plans. These plans contain charts illustrating the Palmer Drought Severity Index for each of Utah's seven climate regions.

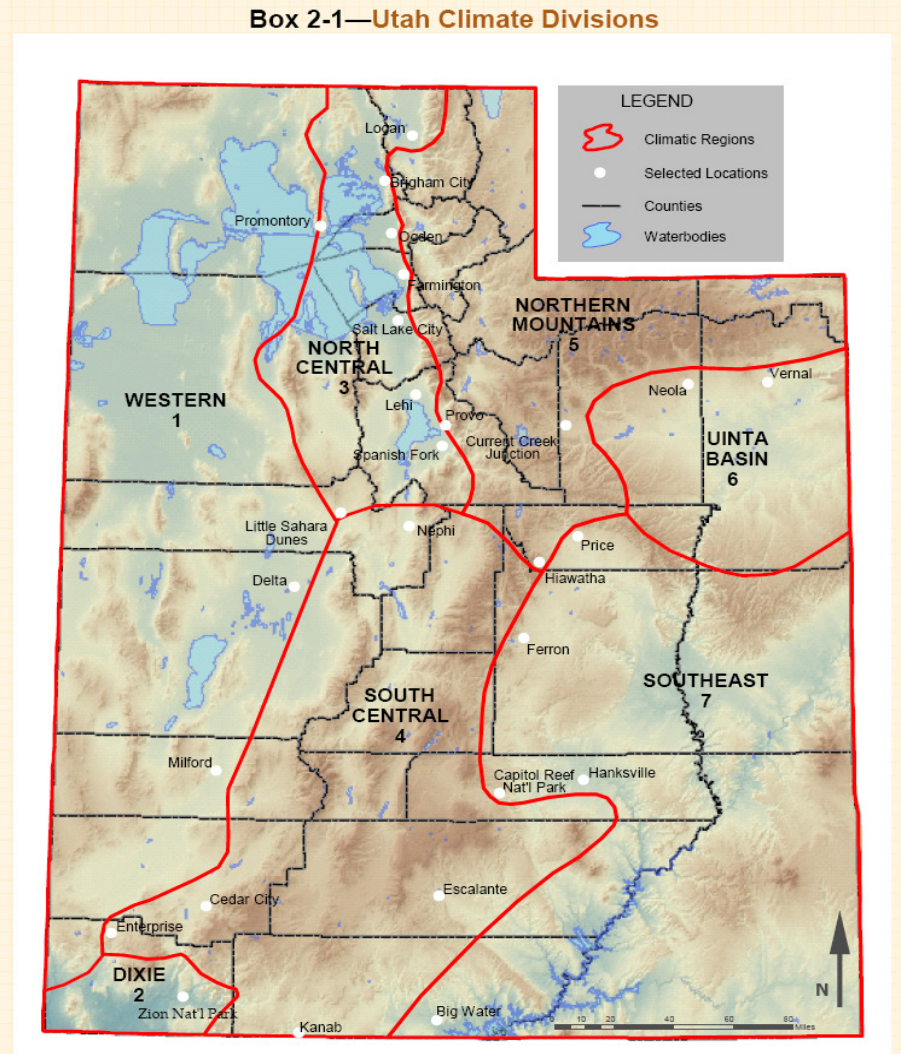
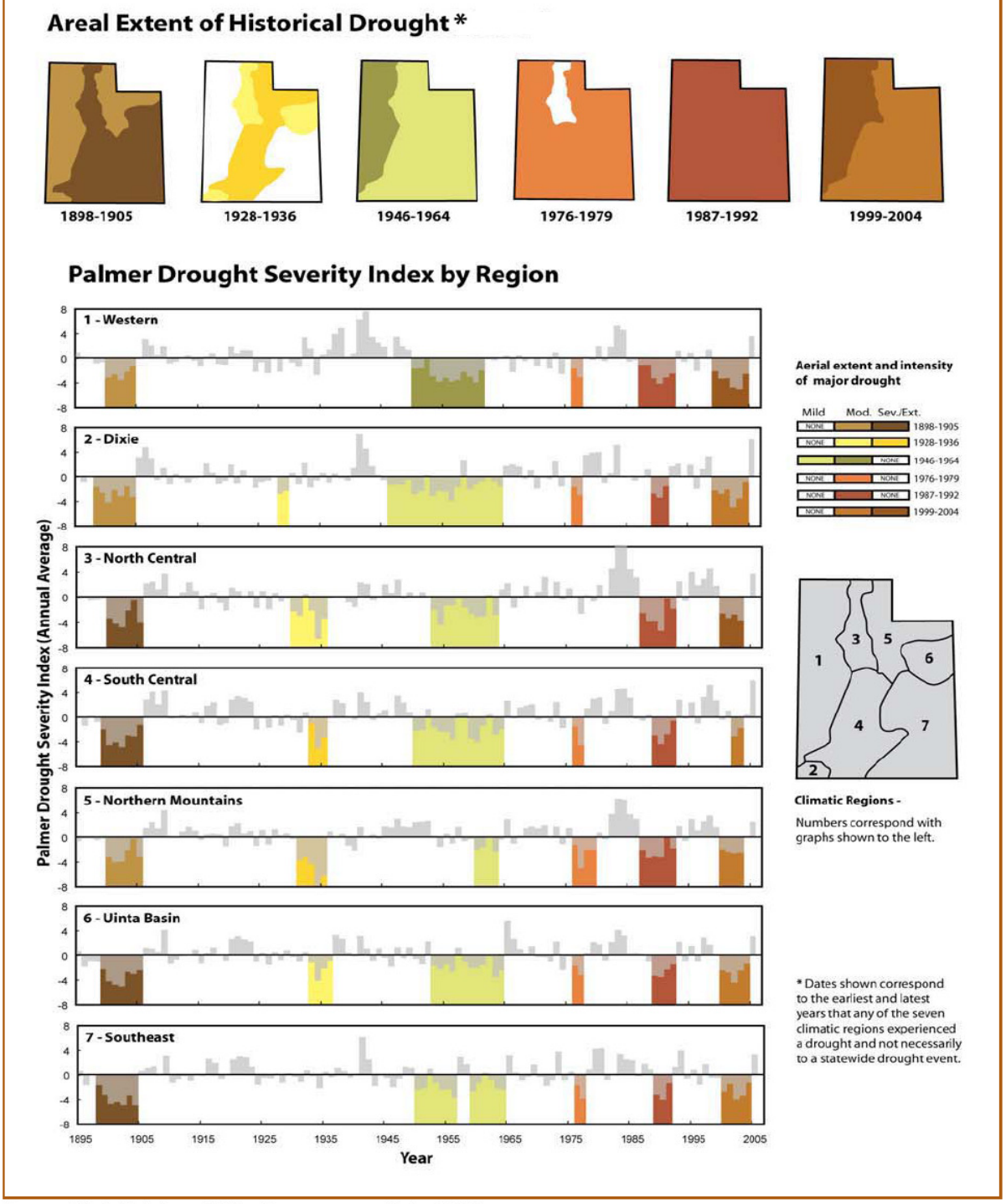


Figure I-7 Source: Utah Division of Water Resources, 2007.

Figure I-8 illustrates Palmer Drought Severity Index values for each Utah climate region as well as the geographical extent of historical droughts for the years 1895 until 2005. It is important to note that the spatial extent of the occurrences of drought in Utah is not geographically limited to only one particular area. In addition, the majority of droughts between the years 1895 and 2005 were not statewide droughts. The figure below indicates that over the past two hundred years, droughts in Utah have become more frequent, however, not as long in duration. On average, droughts that occurred in the 1800's lasted 10 years while droughts in the 1900's lasted eight years (UCCW, 2007).

Figure I-8

FIGURE 2-1
Instrumental PDSI Record—Drought Delineation



Source: Utah Division of Water Resources analysis, 2006.

Sequence of Drought In Utah

The following two paragraphs from the Utah Division of Water Resources, "*Drought in Utah: Learning from the Past – Preparing for the Future"*, April 2007, best describes the typical drought sequence in Utah.

"In Utah, agricultural drought only precedes hydrological drought for dry-crop farmers who do not irrigate. Farmers who irrigate and ranchers who water livestock using stream flow or reservoir storage do not experience agricultural drought (to the same degree as dry-crop farmers) until these parameters are affected and hydrologic drought begins. Even then, farmers who have access to or rely solely on ground water may never truly experience agricultural drought, because even prolonged drought may not completely deplete ground water supplies. However, prolonged drought may make it economically infeasible for farmers to pump ground water if levels decline far enough.

Another nuance to the sequence of drought is the beginning of socioeconomic drought. Sequentially, socioeconomic drought typically does not manifest itself fully until the duration of the drought becomes very long. However, socioeconomic drought technically begins as soon as any economic loss is experienced and can last the entire duration of a drought and beyond. An example of this could be lack of an early snowfall (an indicator of meteorological drought), which prevents ski areas from opening and causes immediate economic loss (socioeconomic drought). While it is often helpful to define drought according to the discussed criteria or phases, drought is almost always a much more complex phenomenon."

Multi Year Droughts in Utah – 1896 – 2004
"Drought in Utah: Learning from the Past – Preparing for the Future", April 2007

1896 – 1905: Large cattle operations folded, leaving small operations to fight over what was left of adequate grazing lands. The drought forced settlers to uproot their families as lands were drying up and water rights were inadequate.

1924 – 1936: The "Dust Bowl Years" affected approximately 75% of Utah. Agriculture productivity was decreased to almost a half of prior years production and the number of farms significantly decreased.

1946 – 1964: Multiple areas within Utah were declared disaster areas. Statewide, impacts could have been worse but were lessened due to steps taken to enhance the water supply.

1974 – 1979: Conditions in seven of Utah's counties prompted the Governor to request Federal Disaster Declarations for these counties. By the end of 1977 the state lost $41 million ($132 million in 2005 dollars due to the drought impacts.

1986 – 1992: Drought blanketed the entire state of Utah for multiple consecutive years, Nationally, 1988 was the most costly drought ever, and until Hurricane Katrina, was the most costly natural catastrophe in U.S. history.

1999 – 2004: The drought produced some of the hottest years and one of the driest years (2002) on record. Statewide reservoir capacity plunged below 50% and farmers and ranchers struggled to continue operations.

Drought in Utah – 2005 – 2010

After five consecutive years of drought (six for the southwestern portion of the state) Utah experienced a much wetter than average 2005 water year (October 2004 – September 2005). The drought conditions, which plagued virtually every western state for half a decade, abated somewhat for the southwestern portion of the country, including most of Utah.

The 2005 water year nearly doubled the volume of water stored in 24 of the state's major reservoirs (excluding Flaming Gorge and Lake Powell). Total water stored in those 24 reservoirs had declined from nearly 3.5 million acre-feet in 1999 to about 1.25 million acre-feet (about 33% of capacity) in 2004.

Although the 2006 water year was not as wet as 2005, it was still been a boon to the state, boosting statewide reservoir storage nearly half a million acre-feet to 2.85 million acre-feet, about 75% of capacity. Utah 's improved reservoir storage situation implies that water supplies should be adequate for agricultural use, as well as municipal and industrial uses throughout the summer and fall of 2006. *Drought in Utah" Learning from the Past – Preparing for the Future, 2007 (Appendix G).*

Drought extreme drought conditions have not reoccurred in the State 2005 - 2010. Areas of the state, southwest and southeastern Utah, will always be susceptible to drought due to climate.

Forecasting drought is one challenge that climatologists are striving to overcome. While short-term weather forecasts are improving in accuracy thanks to more modern technology, drought is a climatic event that does not provide many obvious hints of its onset *(Utah Division of Water Resources, 2007*).

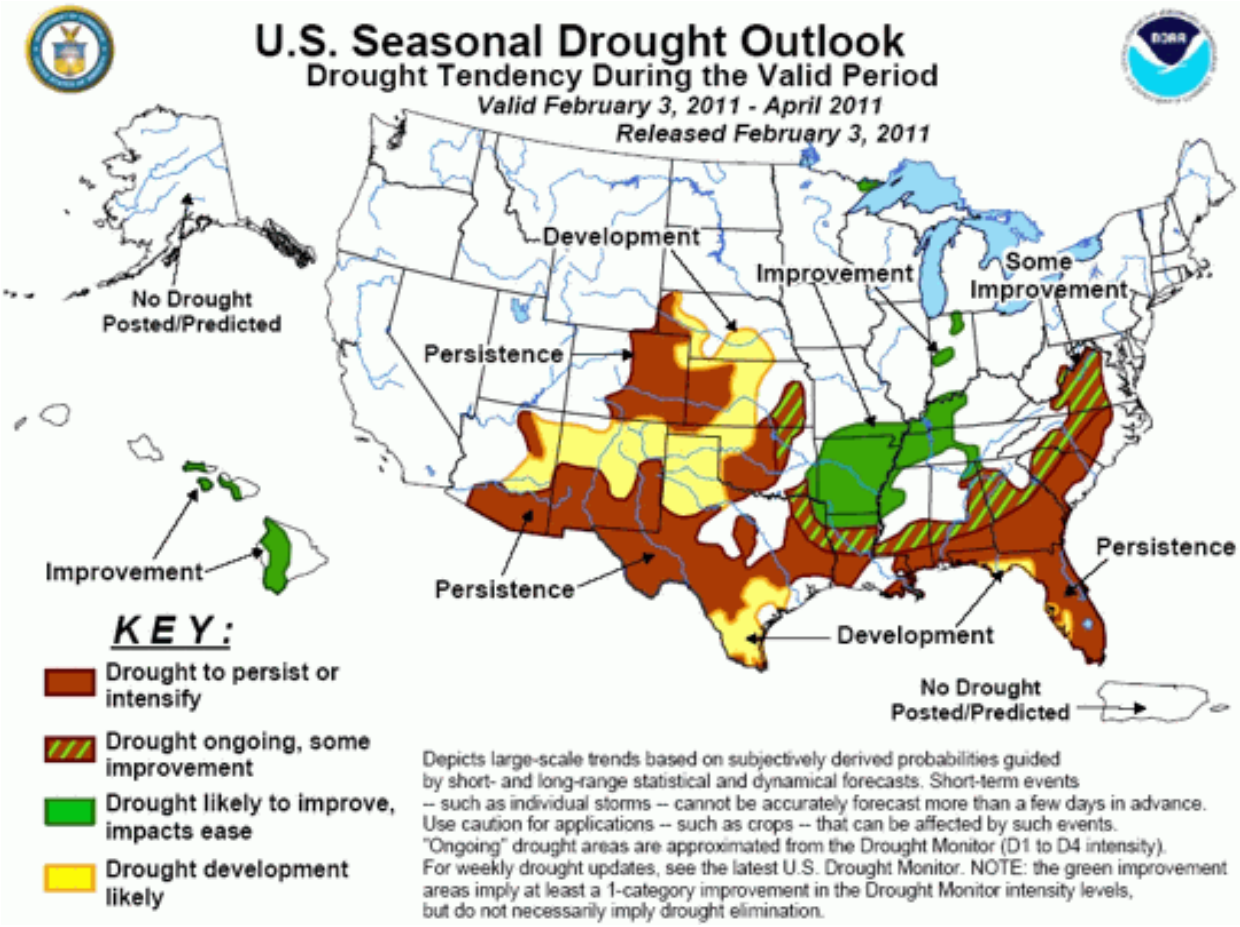
Looking at trends in climate as a result of global warming may be able to provide clues as to the likelihood of drought occurrences in Utah The states that climate across much of the U.S. has been getting warmer for about 20-25 years, especially in the winter and spring.

Utah Monthly Water Supply Reports generate by the NRCS and CBRFC help water users in Utah manage water storage. Each year month water supply reports can vary and extremes are not unusual in any given year or month. What has been determined is Utah is not experiencing drought conditions although southwestern and southeastern Utah is always vulnerable to drought. (*http://www.ut.nrcs.usda.gov/snow/watersupply/wsor.htm)*

"The West, and especially the Southwest, is leading the nation in climate change -- warming, drying, less late-winter snowpack and drought -- as well as the impacts of this change," said Dr. Overpeck, a professor of geosciences and atmospheric sciences and co-director of the Institute of the Environment (2010).

The UCCW indicates that based on historical trends and the current situation of a warming climate, Utah has a likely probability of experiencing another drought period lasting six to ten years beginning sometime between 2015 and 2021. However, prediction of the location and geographical extent of the drought is much harder to predict. Subsequently, this creates difficulties for emergency managers when planning for and responding to droughts. As demonstrated later, continual planning and active mitigation for droughts may be the best method to respond to and recover from future droughts.

Figure I-9



Drought Recovery

It is human nature to want to return too normal as quickly as possible. Therefore, after a prolonged drought, we look at a return to normal precipitation as the end of the drought. Indicators such as a green pasture or a full reservoir are often erroneously used to determine the end of the drought. But the effects of drought linger for several years following a return to normal precipitation. For example, we do not see, after several years of drought, that even though a plant is green it lacks vigor and that the overall biomass of the site has been reduced, therefore, land use may have to continue at a reduced level for a period following a drought. In addition soil moisture may be low inhibiting plant recovery, springs are slow to recover, and wildlife and livestock births are often reduced.

Existing Mitigation

The Department of Natural Resources Division of Water Resources plays a central role in drought mitigation and contingency planning for drought. The Division of Water Resources hosts a multi-agency Governor's Drought Advisory Committee, which meets as needed, to evaluate drought conditions in the state.

The Division of Water Resources also maintains the State of Utah Drought Response Plan. This plan found in Appendix G contains a comprehensive list of federal drought assistance programs and state drought-related assistance programs, as the state does not maintain a specific drought assistance program.

The Division of Water Resources as developed *Drought in Utah" Learning from the Past – Preparing for the Future, 2007,* found in Appendix G. This document emphasizes the need to plan and implement mitigation strategies and actions taken to ensure a reliable water supply before a drought occurs in order to satisfy future water demand during periods of drought. The document includes nine mitigation strategies, response strategies and recommendations.

The Division of Water Resources is currently developing a "*Drought Management Toolkit for Public Water Suppliers, March 2008",* can be found in the Appendices. This document is a simplified outline to give the water supplier ideas from which to initiate mitigation planning and to allow flexibility. The planning process identified in this plan addresses an overall water management methodology. Although this is not a required planning activity, it is high recommended. It can be a standalone document or integrated into current water management plans and long term planning activities. In this document, the *model drought mitigation plan* outlines a broad step-by-step process for assessing a water system, identifying "weaknesses" or vulnerabilities within that system and then developing a plan of action to address the identified weaknesses.

Assessing Vulnerability by Jurisdiction

Requirement §201.4(c)(2)(ii): [The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed … .

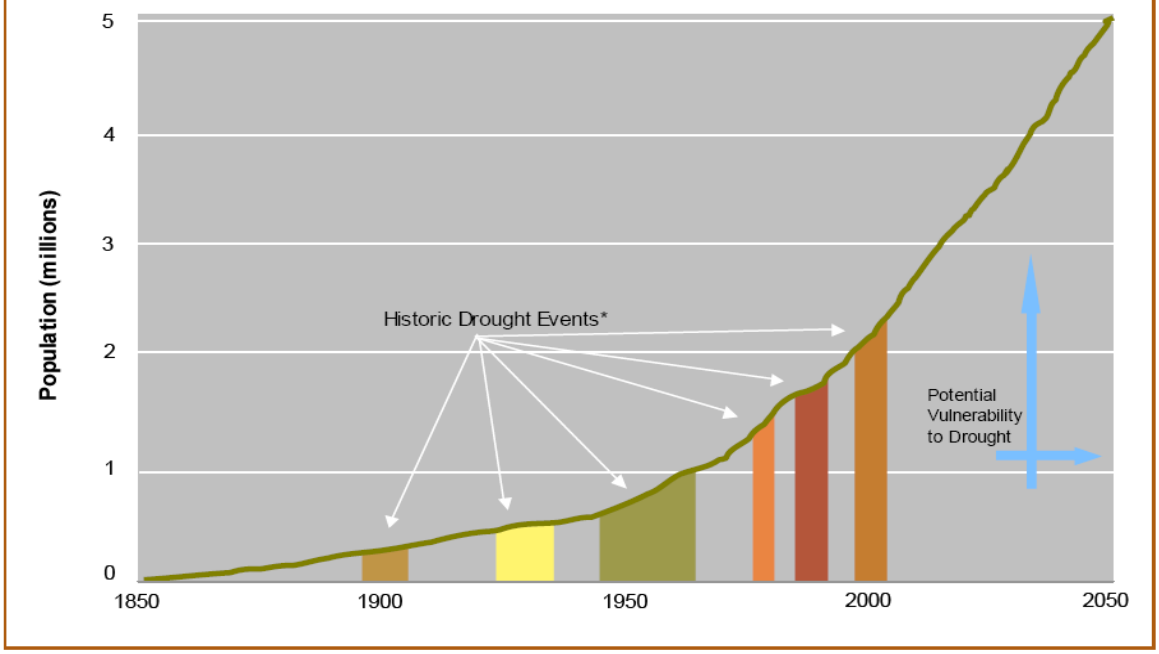
Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

As indicated in the previous section, historical occurrences of drought within the state of Utah have occurred on numerous occasions and are likely to continue with a similar trend in the near future. It is impossible to exactly predict the onset, duration, and spatial extent of a drought however, emergency managers do have the ability to prepare for the impacts of droughts.

The Utah Division of Water Resources emphasizes that the combination of limited water availability and a growing population could result in more environmental, agricultural, economical, and societal stresses resulting from drought.

The figure below illustrates Utah population projections versus drought vulnerability. This chart indicates that population growth within Utah increases the populations' potential vulnerability to drought. The Utah Division of Water Resources recommends that innovative water management strategies are necessary in order to sustain the water needs of the population.

FIGURE 1-4
Population Projections and Drought Vulnerability



*Drought periods contained in the instrumental record as defined and discussed in Chapter 2.
Source: Population data obtained from the Utah Governor's Office of Planning and Budget, 2005.
Utah Division of Water Resources analysis, 2006.

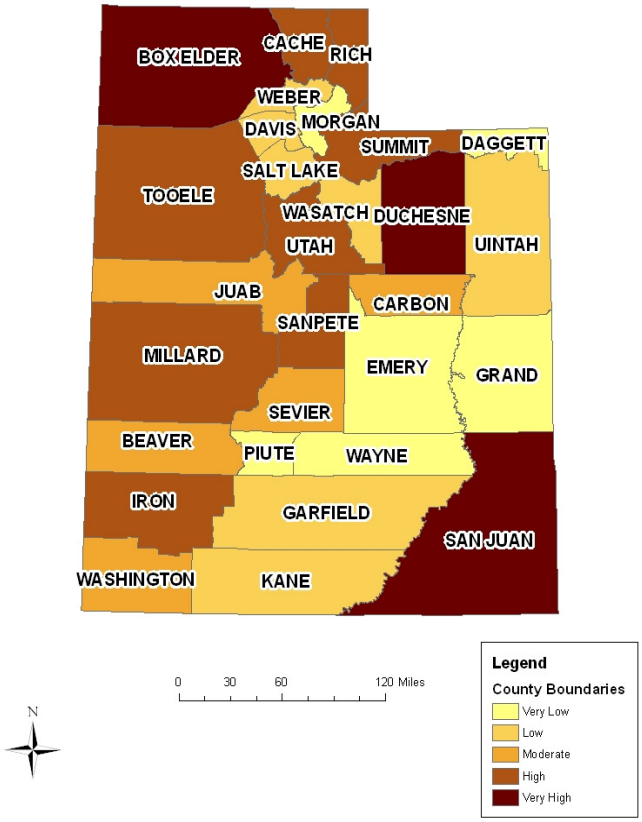
Due to the unpredictability of drought, it is difficult to identify the areas most threatened by drought and to provide loss estimate values. However, historical drought records demonstrate that agriculture is typically the economic sector most impacted by drought.

For example, during the 2002 drought, it is estimated that the agricultural sector lost $150 million ($163.3 million in 2005 dollars). Ranchers were forced to sell their livestock for very low prices and many ranchers were unable to make a profit from their sales. In addition, it is reported that this drought led to increased unemployment with the loss of 6,110 jobs and $120 million ($127 million in 2007 dollars) in income (Utah Division of Water Resources, 2007). It is expected that future droughts will similarly impact the agricultural sector, possibly creating even greater losses in the severity and extent of the drought increases in magnitude.

Drought vulnerability rankings are based solely on agricultural information, typically the economic sector hit hardest by a drought. Economic indicators include cash receipts per county from 2004 to 2005, personal income from farming for 2002, number of acres of farmland per county, number of acres of cropland pre county, and number of cattle per county were used to determine a counties vulnerability to drought. These scores were all normalized and added together to create a vulnerability rating with higher numbers having higher vulnerability.

The 2004 drought vulnerability rankings, and methodology used to determine vulnerability by county, are still an effective measure of drought impact by jurisdiction. Since 2005, the state's drought conditions have improved. Reservoir water storage is an indicator of current drought conditions. See Appendix G.

Potential Drought Impacts per Coutny Based on Agricultural Activities



This original 2004 vulnerability assessment and the map "Potential Drought Impacts per County Based on Agricultural Activities", will also remain in the plan as reference to past drought cycles. The 2008 plan update indicated new census data from the U.S. Department of Agriculture would be available to update economic loss data for drought in Utah.. Officially, the drought ended in 2004. No significant agricultural census data is available that would assist in validating drought impacts by county. A decrease in vulnerability and impact is best portrayed through water supply.

Drought Vulnerability Ranking 2010 Based on Water Supply

1. Box Elder
2. Cache
3. Rich
4. Summit
5. Weber
6. Wayne
7. Garfield
8. Kane
9. San Juan
10. Davis
11. Salt Lake
12. Tooele
13. Morgan
14. Emery
15. Juab
16. Washington
17. Iron
18. Piute
19. Wasatch
20. Grand
21. Daggett
22. Duchesne
23. Carbon
24. Iron
25. Millard
26. Davis
27. Sanpete
28. Sevier
29. Uintah

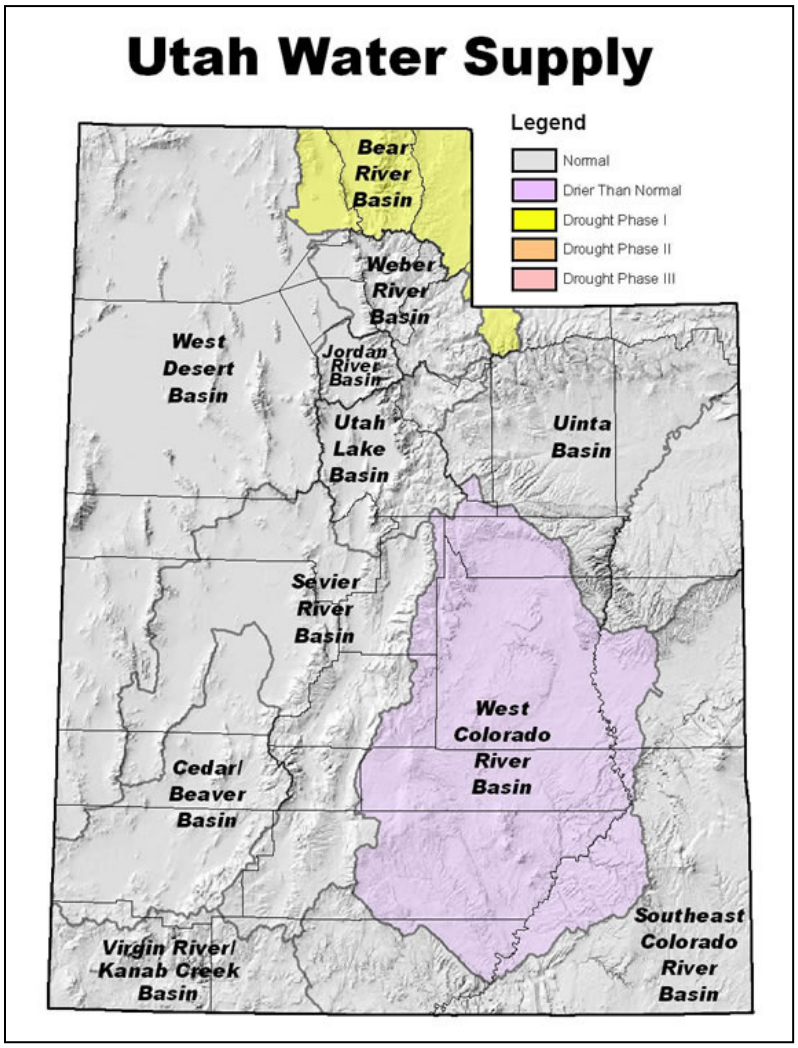


Figure I-12

The counties depicted in Figure I-12 included in the most recent water supply report as being impacted by the drought or the potential for drought. The Surface Water Supply Index (SWSI) by Basin was used to identify current drought conditions.

- Drier than Normal - *Normal to Wet*: West Colorado River Basin
- Drought Phase 1 - *Emerging Drought - Dryer than normal conditions*: Bear River Basin
- The remaining Basins are in normal conditions.

The Utah Division of Water Resources makes several recommendations pertaining to the management of droughts. They suggest that mitigating the drought prior to it's onset can be less expensive than responding after the drought has begun.

In order to do this, strategies such as water redistribution, conjunctive management, water systems interconnections, water development projects, water reuse, demand management (alternative landscaping and incentive pricing) water metering, leak detection projects, and weather modification projects are recommended.

Estimating Potential Losses by Jurisdiction

Requirement §201.4(c)(2)(iii): [The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

Drought conditions, which plagued virtually every western state for half a decade, abated somewhat for the southwestern portion of the country, including most of Utah in 2005.
No additional drought losses have been identified to assist in supporting and updating potential losses first identified in the 2004 and 2008 Plan.

Since it is not known if the state may be entering into another drought cycle, the information developed for the 2004 and again support in 2008 estimation for potential losses will remain as the most current potential loss by jurisdiction. The information will also be used to document and track losses due to drought.

The Governor's Office of Planning and Budget (GOPB) compiled drought loss numbers from 2002, for the 2003 Economic Report to the Governor. The Economic Report to the Governor suggests the current drought has reduced employment change by 0.4%. During 2002, job change was –1.0%. Without the drought, job change might have been –0.6%, 0.4% higher than what actually occurred. No additional economic loss data has been generated by the GOPB since the 2003 report

Best estimates in 2003 were that livestock sales are down $100 million due to the drought; hay sales are down $50 million; and, because of drought related fires, tourism sales are down $50 million. The combined effects of the drought in these three sectors resulted in a loss of over 6,100 jobs during 2002, and over $120 million in lost income.

The hardest hit sector was agriculture, where 2,600 jobs and almost $40 million in income were lost. The sectors serving tourists (retail trade and services) were the next hardest hit sectors. Services lost about 1,300 jobs and $25 million in income. Retail trade lost 1,000 jobs and almost $15 million in income.

It is expected droughts in the future will have similar losses. Basing future losses on past losses on the counties of Box Elder, Utah, Cache, Rich, Sanpete, Millard, Duchesne, San Juan, Weber, Tooele, and Beaver will suffer the largest economic losses in future droughts. Drought is a compounding event, with economic losses getting larger as drought conditions persist. Yearly levels of snow pack, precipitation, and water storage from 2005 – 2010 have varied but severe

drought conditions have not returned. Utah may experience dryer than average conditions to moderate drought conditions in the near future.

The Utah Division of Water Resources mentions in their drought report that large and significant data gaps hinder the quantification of drought impacts in all sectors of the economy and society. They suggest that tax revenues and other potential economic indicators of drought impacts be monitored at all levels of government in order to improve evaluation methods and to better understand drought impacts.

Assessing Vulnerability of State Owned Facilities

Requirement §201.4(c)(2)(ii): [The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed … .

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

Although state owned facilities are seldom threatened by drought directly, drought does increase the likelihood of wildfire. Thus, facilities at risk to wildfire are also at risk to drought as prolonged drought can heighten the wildfire risk. Drought also as an effect on the budgets of many state parks and the tourism industry relying on water based recreation such as river running and water skiing. Individual State Park Hazard Mitigation Plans include drought mitigation recommendations.